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A New IAB Iron Meteorite From China

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A NEW IAB IRON METEORITE FROM CHINA. K.V. Ponganis[1], B. Lavielle[2], B. Spettel[3], V.F. Buchwald[4], K. Nishiizumi[5], M.W. Caffee[6], and K. Marti[1], [1] Dept. of Chemistry & Biochemistry, UCSD, La Jolla, CA 92093-0317, USA (kponganì@ucsd.edu), [2]Laboratoire de Chimie Nucléaire Analytique et Bioenvironnementale, U.M.R. 5084 of CNRS, University of Bordeaux I, BP120, Le Haut Vigneau, 33175 Gradignan Cedex, France, [3] Max-Planck-Institute für Chemie, Postfach 3060, D-55020 Mainz, Germany, [4] Ingeborgvej 4, DK-2920 Charlottenlund, Denmark, [5] Space Sciences Laboratory, UC Berkeley, Berkeley, CA 94720-7450, USA, [5] Center for Accelerator Mass Spectrometry, Lawrence Livermore National Laboratory, Livermore, CA 94550, USA.

Introduction: Dr. W. Wei, at UCSD, provided our laboratory with chips from a suspected iron meteorite. The mass (>10 kg) was found approximately 8 km northwest of Zhongshan in Guangxi province by a farmer in his fields. This mass has now been identified as an IAB iron meteorite (provisional name Zhongshan #1) based on its composition, N signature, and petrographic analysis. A second chip from a much larger mass (Zhongshan #2), still in the ground, was recently made available and work is in progress on it, but not reported.

Elemental Composition: A 65 mg sample of Zhongshan #1 was analyzed by INAA at the Max Planck Institute in Mainz. Results are summarized in Table 1. The concentration of diagnostic elements for iron meteorites, such as Ni, Ga, Ge, and platinum group metals, are consistent with the IAB/IIICD group (see Figure 1). [1]

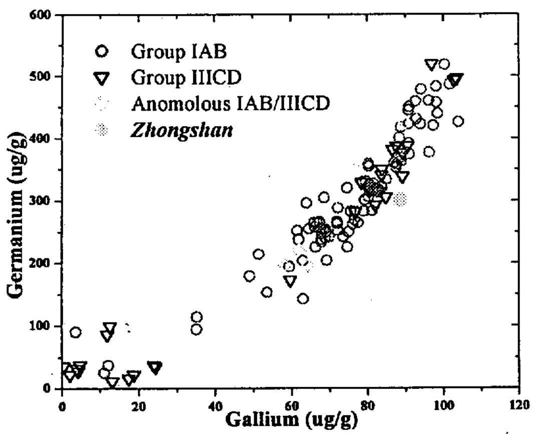

Figure 1. Position of Zhongshan sample #1 in a Ge vs. Ga plot for the IAB/IIICD iron meteorites. Group data is from [1].

Isotopic Signatures of N and Xe: Both N and Xe isotopic signatures were done at UCSD on Zhongshan sample #1. The step-release profile of N is shown in Figure 2. In iron meteorites the signature of indigenous N is highly variable and can be used for classification. [2,3] Nitrogen isotopic analysis indicated that the N step-release profile in this sample is consistent with the IAB/IIICD group, [4] although the total N amounts are extremely small (0.57 ppm). The average $\delta^{15}N$ for steps 1400 °C to 1600°C is -(78±25) ‰. There is a different signature for the 900 °C to 1000 °C temperature steps (avg. $\delta^{15}N$ = -(40±7) ‰), suggesting the presence of at least two N sources in the sample. The Xe data can be used to trace the presence of inclusions like silicates. [5] The $^{129}Xe/^{132}Xe$ ratio (1.38±0.04) shows a ^{129}Xe excess for 1200°C≤T≤1600°C, which is consistent with the presence of minor inclusions.

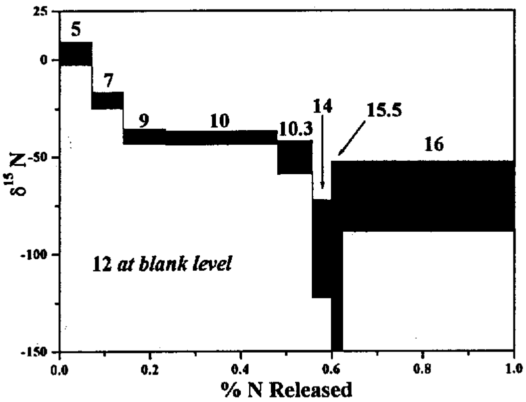

Figure 2. The stepwise pyrolysis of the Zhongshan iron sample #1. Temperature is in hundreds of °C. The large uncertainties for the steps ≥ 1200°C reflect the low concentrations of N and the variable and large blank corrections.

Cosmogenic Components: An analysis of He, Ne, and Ar on Zhongshan #1 was done at Laboratoire de Chimie Nucléaire Analytique et Bioenvironnementale (see Table 2). The observed ratio $^{36}Ar/^{38}Ar$ of 0.6194 represents a spallation component from a shielded location. The $^{4}He/^{21}Ne$ ratio (374 ±17), the shielding parameter, supports this conclusion.

We can only estimate the cosmic-ray exposure (CRE) age for this meteorite since work on the ^{36}Cl concentration is still in progress. However, assuming a simple exposure history and based on the Ar concentration and on the $^{4}He/^{21}Ne$ ratio, the ^{36}Cl value should be ≤11 dpm/kg, (see Figure 3). Using a ^{36}Ar value of 11.38×10^{-8} cm^3 STP/g, the CRE age is estimated to be ≥440 Ma.

Petrographic Analysis: A sample of Zhongshan #1 was studied at the Geologisk Museum, Copenhagen. A chip was polished, and then, etched lightly with 1% Nital before analysis.

The bulk of the specimen is kamacite, with a bandwidth estimated at (11.9±0.3)mm. The kamacite, which is rich in Neumann bands, is penetrated by a multitude of shear zones that bend the Neumann bands and shear

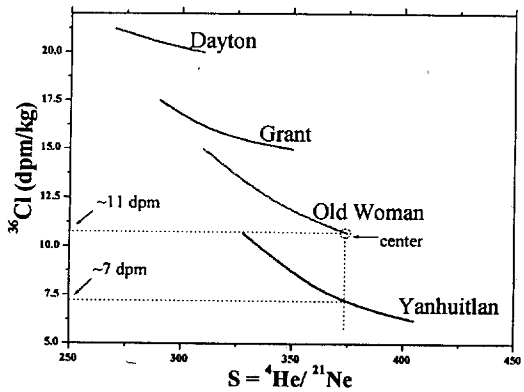

Figure 3. Meteorite Shielding: Size vs. Depth. Using the shielding parameter S = 374 and the ^{36}Cl profiles from large irons, the expected ^{36}Cl concentration is $\leq$11 dpm/kg. The CRE age is calculated using the following equation: Tc (in Ma) = 427 x [^{36}Ar]/[^{36}Cl], where [^{36}Ar] is in 10^{-8} cm^3 STP/g and [^{36}Cl] is in dpm/kg. [6] The estimated CRE age is $\geq$440 Ma, based on Old Woman (recovered mass 2753 kg) and Yanhuitlan (recovered mass 421 kg) systematics.

the minerals. The Vickers hardness (200 g load) of the kamacite is: 198 - 199 - 228 - 232 - 233 - 245. These values are high for kamacite, but are due to the significant cold deformations observed in the microstructure.

Taenite is present as up to 0.06 mm wide lamellae, alternating in bluish and brownish colors, suggesting a submicroscopic two-phased structure (probably tetrataenite and associated structures). Three or four plessite fields of the comb plessite variety are present, the largest field being 3 x 1.5 mm. The bulk Ni (6.6%) seems a little low for the average structure observed.

Schreibersite is abundant as grain boundary crystals (up to 0.08 mm wide). Rhabdites are very common, but most are <0.02 mm across. Sub-boundaries of the kamacite are decorated with 0.002 mm crystals, probably of phosphides, but possibly supplemented by some carbides. Both schreibersite and rhabdites are severely sheared and displaced. Terrestrial corrosion has had easy access along the grain boundaries with sheared schreibersite, both because of the capillary action and because of the Ni gradient in kamacite adjacent to schreibersite.

The fusion crust and the heat-affected α_2 zone have been lost by weathering. However, heavy deformation and shearing has generated locally sufficient heat (>800 °C for a short period of time) to transform kamacite to serrated α_2 grains and remove the Neumann bands. This friction re-heating may have occurred when the meteorite suffered a violent split-up upon entering the Earth's atmosphere. The deformation of the present specimen indicates that it is only a fragment of a bigger shower, consistent with the find nearby of a much larger mass of iron (> 1 ton). The absence of cohenite, graphite, and troilite may be due to the fact that the analysis was performed on a very small, unrepresentative fragment.

Conclusion: Preliminary N isotopic analysis on Zhongshan sample #1 suggested that the iron mass might be a IAB/IIICD type. Petrographic inspection and INAA analysis has verified that this sample is a typical member of the coarse octahedrites, of the resolved chemical group IAB. Zhongshan #1 was well-shielded (see Figure 3). Its estimated CRE age is $\geq$440 Ma. Determination of the radionuclides and noble gases on Zhongshan sample #2 (in progress) will give useful information on the exposure and shielding history of the meteoroid and its possible atmospheric break-up.

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References: [1] Choi, B.G., *et al.*, (1995) *Geochimica Et Cosmochimica Acta* **59**: 593-612. [2] Prombo, C.A. and Clayton, R.N., (1993) *Geochimica et Cosmochimica Acta* **57**: 3749-3761. [3] Franchi, I.A., *et al.*, (1993) *Geochimica et Cosmochimica Acta* **57**: 3105-3121. [4] Ponganis, K.V., *et al.*, (2000) *Meteoritics and Planetary Science* **35 (Supplement)**: A128-129. [5] Ponganis, K.V. and Marti, K., (2000) *LPSC* **XXXI**: [6] Lavielle, B., *et al.*, (1999) *Earth and Planetary Science Letters* **170**: 93-104.

Table 1. Trace elements of Zhongshan #1 sample. Fe is 91.94% (3% error) and Ni is 6.60% (4% error), by mass.

Element	ppm	% error	Element	ppm	% error	Element	ppm	% error
Co	4330	3	Mo	8.20	7	Re	0.200	5
Cu	136	4	Ru	5.70	15	Os	2.90	7
Ga	88.6	3	Pd	3.60	15	Ir	2.34	3
Ge	301	7	Sb	0.390	10	Pt	7.20	7
As	11.9	4	W	1.01	5	Au	2.22	3
Se	<4	-						

Table 2. Cosmogenic noble gas concentrations (in 10^{-8} cm^3 STP/g) and ratios for the Zhongshan #1 sample.

	^{4}He	^{21}Ne	^{36}Ar	^{38}Ar	^{3}He/^{4}He	^{36}Ar/^{38}Ar	^{4}He/^{21}Ne	^{4}He/^{38}Ar	^{21}Ne/^{38}Ar
value	1120	2.995	11.38	18.37	0.2435	0.6194	~374	61.0	0.1631
error (2σ)	37	0.093	0.19	0.29	0.0040	0.0037	17	2.3	0.0057

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